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Motion tracking from gradient induced signals in electrode recordings

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Presentation Abstract

Presentation:	**Motion tracking from gradient induced signals in electrode recordings**
Location:	Lecture Room 11
Presentation Time:	Saturday, Oct 08, 2011, 4:10 PM - 4:22 PM
Authors:	**M. B. Vestergaard**[1,2], J. Schulz[3], R. Turner[3], L. G. Hanson[1,2]; [1]Danish Research Centre for MR, Copenhagen University Hospital Hvidovre, Hvidovre, Denmark, [2]Department of Electrical Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark, [3]Department of Neurophysics, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.
Topic:	++224: Motion, artefacts, quality control
Abstract:	**Introduction:** Gradient switching induces currents in wire loops (Faraday's Law of Induction) thus resulting in gradient artefacts on EEG recording during MRI. As these depend on the orientation and location of the loop, they contain useful information. It is demonstrated that subject motion can be tracked based on EEG-like recordings, but with inter-connected electrodes. **Methods:** Six loops were secured to a normal subject's head. During EPI recording (22 slices, matrix 64x64,

TE/TR=43/2150ms), the subject performed large stepwise head movements. The gradient-induced signals from each loop were recorded with an EEG-system (BrainProducts GmbH, BrainAmp MR plus). The signal variations are linear combinations of contributions from each gradient coil, so individual gradient waveforms were estimated by independent component analysis [1] for a motionless period. Each loop recording was subsequently split into smaller time windows (2.44 s) and decomposed into a linear combination of contributions from individual gradient coils. Under the assumption of linearity ensured by small movements, the coefficients were related to head motion parameters by calibration (relative translation x,y,z and rotation θ, φ, ω) done by coregistration with SPM8 [2]. Following calibration, motion parameters were extracted from the varying coefficients, thus providing tracking of motion.

Results: The figure shows the estimated tracking parameters (x,y,z, θ, φ, ω) from the loop recordings (red) compared to parameters from the widely used SPM software (blue). The data is split into calibration and validation periods as indicated. The estimated parameters from the loop recordings are seen to follow the parameters from the SPM software, thus demonstrating proof of concept.

Discussion: The similarity between the estimated parameters and the SPM-parameters indicates that head motion can be extracted from loop recordings without requiring knowledge of loop geometry or placement. While the calibration relies on stepwise motion, the subsequent motion can be tracked continuously. Relative head/loop motion, non-stepwise motion, and large motions, violate the assumptions and compromise precision. However, some of the same principles [3] are used in a commercial tracking system (EndoScout, Robin Medical Inc), which indicates that optimization may improve precision well below millimetres.

References:

[1] A. Hyvärinen, 1999, Fast and Robust Fixed-Point Algorithms for ICA, IEEE Transactions on Neural Networks 10(3):626-634.

[2] SPM 8 - Statistical Parametric Mapping. Institute of Neurology, College of London. www.fil.ion.ucl.ac.uk/spm/

[3] Roth A., Nevo E.,2010, Method and apparatus to estimate location and orientation of objects during MRI, patent appl. 20100280353.